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the kaolin. The presence of oxidized and kaolinized garnet gneiss at a depth of 85 feet is equally suggestive of the derivation of the kaolin from a superficial source. A summary statement of these two hypotheses to explain the origin of kaolin deposits is given, but the writer has no definite basis for deciding between them. The shattered zone of quartzite in which the kaolin occurs has a known width of 1,000 feet and a length of 7,000 feet. This kaolinitic quartzite rock can be easily crushed and is suitable for making silica brick of the ganister type or the kaolin can be washed from the crushed material and the quartz used for silica sand.

North of the kaolin locality a number of graphite deposits have been opened along the contacts of pegmatite, pyroxene granite, syenite, and Grenville limestone. The ore consists of aggregates of orthoclase, wollastonite, diopside, scapolite, and graphite. These relations and associations of minerals indicate that this material was formed by the interaction of emanations from the igneous intrusions and the limestone.

J. F. W.

Map of the North Pacific. By W. E. JOHNSON. U.S. Coast and Geodetic Survey, Map No. 3080, North Pacific Ocean; scale 1:20,000,000; dimensions 14 by 41 inches. Price 25 cents.

A new base map of the North Pacific Ocean on the transverse polyconic projection has been prepared by W. E. Johnson, Cartographer, of the U.S. Coast and Geodetic Survey of the Department of Commerce, and is now available for distribution. This system of projection was devised by Ferdinand Hassler, who was the organizer and first Superintendent of the U.S. Coast and Geodetic Survey. This projection was computed and constructed by C. H. Deetz, Cartographer, U.S. Coast and Geodetic Survey.

The Mogollon District, New Mexico. By HENRY G. FERGUSON. Bulletin 715-L, United States Geological Survey, Government Printing Office, Washington, D.C., 1921. Pp. 34, pls. 6, figs. 2.

The Mogollon (Mo-go-yohn) or Cooney district lies in southwestern New Mexico, about fourteen miles from the Arizona line. The district was discovered in 1875, when James Cooney found rich silver-copper ores there. Since then the mines have yielded about $16,000,000 worth of ores (estimated to 1917).

The topography is generally very rugged, especially on the eastern edge of the district, which lies along the Mogollon Range. The rocks are dominantly Tertiary lavas, with interbedded sandstones. Faulting is extensive, and the fault fissures have been mineralized. In Quaternary times erosion was great and thick gravels accumulated; the gravel deposition was followed by more faulting, the fault plane paralleling the present front of the range, with downthrow on the west. Renewed erosion followed this last orogeny. The Tertiary formations, chiefly igneous, reach 8,000 feet in thickness. The flows are chiefly andesites and rhyolites, though there are a few basaltic lavas. Of the total thickness mentioned, 6,400 feet are pyroclastics and flows; the remainder are stream-laid sediments. Erosional unconformities within the sequence are common. Intrusives are represented by dikes of rhyolite and basalt.

Structurally the area is affected by complex normal faults; two periods of faulting are recognized—one before, the other after, the deposition of the rival gravels. The former was far more widespread, and nearly all the fault fissures of this period are now the site of fissure veins trending roughly north-south or northwest-southeast; one of these—the most prominent—can be traced for a length of seven miles, and the fault involves a displacement of a thousand feet or so. The first faulting resulted in increase erosion and the development of mature topography; on the west slope of the region there was at this time a broad valley, which later became filled with gravel to a depth of several hundred feet. Then came the great fault that now defines the front of the range; this renewed erosion and initiated the present cycle with its higher flat benches and lower steep canyons.

The ore deposits of the region are all in veins closely connected with the faults. The richest are the small ones lying along the fault fissures that are distributive from the great seven-mile fault (Queen fault) mentioned above. Locally the mineralization shifts from the main fissure to minor fissures in the wall, indicating that mineralization was not contemporaneous with the faulting. The mineral content of the veins includes quartz, calcite, a little adularia, and flourite (locally plentiful). Argentite, with small amounts of associated pyrite, chalcopyrite, bornite, galena, and sphalerite are the metaliferous primary minerals; in a few veins copper minerals—bornite, chalcopyrite, chalcocite, and tetrahedrite—predominate. Quartz and calcite are the chief gangue constituents. Oxidation is shallow and irregular. Sulphide enrichment appears to have been somewhat effective. The oxidized ore bears cerargyrite, native silver and gold, basic copper carbonates, limonite, copper pitch ore, cuprite, and manganese oxides. Chalcocite, covellite, some argentite, pyrite, and native silver are probably due to sulphide enrichment, but a part of the argentite and pyrite and all of the bornite, chalcopyrite, tetrahedrite, and galena are apparently primary.

Quartz was the first mineral to be deposited and it was followed at once or even accompanied by the greater part of the sulphides. The later stages of vein-filling were marked by coarsely crystalline calcite, largely manganiferous and barren of sulphides. Mineralization of the wall rock is not prominent; in andesites, pyrite has penetrated the rock for short distances from the veins, or the rock is cut by veinlets of quartz, calcite, and copper sulphides. The dark silicates in the andesites are often almost completely altered, and calcitization is common. The rhyolitic country rock near the veins shows some secondary silicification, and the feldspars are frequently replaced by quartz with an apparent decrease of volume.

Although the oxidation zone is generally shallow, it may extend to the 500- or 700-foot levels. Argentite appears here and there as filling in minute cracks, apparently later than the veins, and pyrite clearly of later origin is seen in fissures in the quartz. No sulph-arsenic or sulph-antimony salts of silver, such as commonly characterize many sulphide enrichment zones, are found, but chalcocite and a small amount of covellite do attest the effectiveness of some enriching action. Probably sulphide enrichment is appreciably active only where unusually favorable conditions, such as later faulting, were present. The ground water-level lies very deep and the mines are dry, except along the Queen fault.

The ore shoots are 300 to 600 feet in drift length and about as long parallel to the dip, with widths averaging 5 to 15 feet. They tend to show flat bottoms, which is thought by the investigator to be suggestive of enrichment.

The peculiar localization of the productive veins within a small district not over one square mile in extent is attributed to the faulting, which only produced the throw necessary to bring the ore within reach of the surface over a very small area; greater or lesser throws either resulted in too deep an erosion or in the exposure of the barren low-temperature manganiferous-calcite veins.

The important mines are the Cooney, Little Fanney, and Last Chance; the last being the largest. In the past twenty-five years the Last Chance mine has yielded about $7,500,000, worth of ore. The metals obtained are gold and especially silver, and a high-grade ore lies close to $20 a ton in value.

C. H. B., Jr.